

Seismic Analysis of Irregular Building Frames with Soil Structure Interaction

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ABSTRACT

Seismic response of structure is extremely complex because of the non-linear behavior soil during earthquakes. Seismic design of structures is generally carried out assuming fixed base ignoring the flexibility of soil. The main objective of the study is to investigate the significance of effect of soil structure interaction on building with mass irregularity. The dynamic contact approach was utilized to simulate pounding between the adjacent buildings. Nonlinear finite element analysis was performed for two adjacent multi-story structures with four different configuration representing cases that can exist in reality. The seismic response of the studied cases generally emphasized that ignoring the soil flexibility and/or the contribution of the infill panels may significantly alter the response of adjacent structures. Response spectrum analysis has been carried out and the parameters like time period, base shear, roof top displacement and storey drift of the building frames resting over foundation and soil media has been studied.

KEYWORDS: Seismic analysis, soil structure interaction, vertical irregularity, mass irregularity, response spectrum. structure, soil structure, frames with soil structure, irregular buildings, plan of buildings

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INTRODUCTION:

An earthquake cause, failure of structure which starts at points of weakness. Discontinuity in mass, stiffness and geometry of structure cause weaknesses in structure. The structures which having such type of discontinuity are termed as Irregular structures. Building with vertical irregularities are one of the major reasons of failures of structures during earthquakes. It should be underlined that the research available in the literature has been conducted to study separately either the SSI effects, or the infill effects, on the seismic pounding of adjacent buildings. According to the author's knowledge, no research has been devoted to cover both effects simultaneously. Therefore, the present research aims to study the effects of infill panels combined with the SSI effects on the earthquake-induced structural pounding between neighboring structures. Four different structural cases were utilized to simulate scenarios that may exist during construction stages of adjacent buildings. The study was further extended to compare the pounding-involved behavior versus the independent behavior of structures without collisions, focusing much on dynamic behavior of single frames. Irregular buildings constitute a large portion of the modern urban infrastructure. The group of people involved in constructing the building facilities, including owner, architect, structural engineer, contractor and local authorities, contribute to the overall planning, selection of structural system, and to its configuration. This may lead to building structures with irregular distributions in their mass, stiffness and strength along the height of building.

SCOPE and OBJECTIVE

Scope:

- Regular and symmetrical structures exhibit more favourable and predictable seismic response characteristics than irregular structures. Therefore, the use of irregular structures in earthquake-prone areas should be avoided if possible.
- In case of stiffness irregular structure concentration of mass on floor level causes grater effect on inter storey drift so that proper design is necessary. To Analysis Irregular building with Soil Structures Interaction Subjected to Seismic Force.

Objectives:

To study the effect of vertical geometric irregularity and performance level of the structure. Seismic Analysis of Vertically Irregular RC Building Frames

- Comparison between regular and vertical irregular frame on the basis of shear force, bending moment, storey drift & node displacement etc.
- To obtain the Seismic performances of different irregular buildings located in severe earthquake zone (III) of Maharashtra, India, and also identify the most vulnerable building among them.
- Evaluation of design lateral forces on buildings with irregularities namely vertical geometric irregularity (irregular shear wall), mass irregularity and stiffness irregularity subjected to biaxial excitation and to

compare the results of different structures. A comparative study was performed on 3-D analysis model created in ETABS, a commercial computer program for the analysis of structures.

- Implement the proposed multi-scale modeling technique to assess the seismic performance of the vertical irregularity of RC building frames to evaluate the seismic safety and collapse vulnerability of existing buildings.

REVIEW OF PREVIOUS STUDIES

The seismic response of vertically irregular building frames, which has been the subject of numerous research papers, started getting attention in the late 1970s. A large number of papers have focused on plan irregularity resulting in torsion in structural systems. Vertical irregularities are characterized by vertical discontinuities in the distribution of mass, stiffness and strength. Very few research studies have been carried out to evaluate the effects of discontinuities in each one of these quantities independently, and majority of the studies have focused on the elastic response. There have also been detailed studies on real irregular buildings that failed during earthquakes (Mahin et al., 1976; Kreger and Sozen, 1989), but such studies are small in number. Many researchers studied the response of set-back structures (Humar and Wright, 1977; Aranda, 1984; Moehle and Alarcon, 1986; Shahrooz and Moehle, 1990; Wong and Tso, 1994). In set-back structures there is a sudden change in the vertical distribution of mass, stiffness, and in some cases, strength. A set-back structure is thought of being made up of two parts: a base (the lower part having many bays), and a tower (the upper part with fewer bays). Following is a brief review of the work that has been done on the seismic response of set-back structures.

V. RejendraKumar [Feb 2017] :- This paper deals with the comparison between equivalent static technique & response spectrum technique. The earthquake effect lead to the damage the property and many people loss of life. So we have to know the structural performance under seismic load before construction. Method of analysis: Adopt the equivalent static and response spectrum techniques to analyze the model for the present study and observe the lateral displacement of the structure in a regular and irregular structure in various zones. Finding: The major parameters considered in this study to observe the seismic conduct of various zones i.e. ZONE-II, Zone-III, ZONE-IV & ZONE-V and the base shear, lateral displacements in various levels. According to IS-1893-2002 seismic loads are calculated. The lateral forces are calculated by using the STAAD Pro and the results are compared between two Zones in both response spectrum and seismic coefficient technique. Applications: To analyze the building as per code IS 1893-2002 part I criteria for earthquake resistant structure. Dynamic analysis of the building using response spectrum method. Building with different lateral stiffness systems. To get economical and efficient lateral stiffness system.

Mr. S. Mahesh , Mr. Dr. B. Panduranga Rao [Dec. 2014] :- The behaviour of G+11 multi story building of regular and irregular configuration under earth quake is complex and it varies of wind loads are assumed to act simultaneously with earth quake loads. In this paper a residential of G+11 multi story building is studied for earth quake and wind load using

ETABS and STAAS PRO V8i. Assuming that material property is linear static and dynamic analysis are performed. These analysis are carried out by considering different seismic zones and for each zone the behaviour is assessed by taking three different types of soils namely Hard , Medium and Soft .Different response like story drift, displacements base shear are plotted for different zones .

Ravi Kiran Sridhar:-It's a very big challenge that building or structure must withstand lateral forces such as earthquake and wind load. In the present work, the comparative analysis of various structures is performed using SAP 2000. The main aim of the project is comparative study of the stiffness of the structure by considering the three models that is Regular Structure, Plan irregular structure and Vertical irregular structure. All these three models are analyzed with static and dynamic earthquake loading for the Zones II, III, IV & V. The results are tabulated and graphs are plotted for displacement, drift, base shear and time period. Based on the results and discussion the structural behavior and stiffness is concluded for regular and irregular structures, among these structures regular structure shown maximum displacement and drift for all the zones in both static and dynamic analysis.

Sudhanshu:- Presents a study of two R.C. building one symmetrical and one unsymmetrical in plan (designed according to IS 456:2000) are analyzed using pushover analysis and redesigning by changing the main reinforcement of various frame elements and again analyzing. The results of analysis are compared in terms of base shear, storey drift, spectral acceleration, spectral displacement and storey displacement. Also they studied the performance of R. C. Building by providing shear wall. They conclude that performance increases on increasing reinforcement of columns only resulting into an appreciable decrease in the maximum roof displacement both symmetrical as well as unsymmetrical building. They also conclude that performance of the building decreases when the sectional size of beams and columns are reduced while keeping same reinforcement.

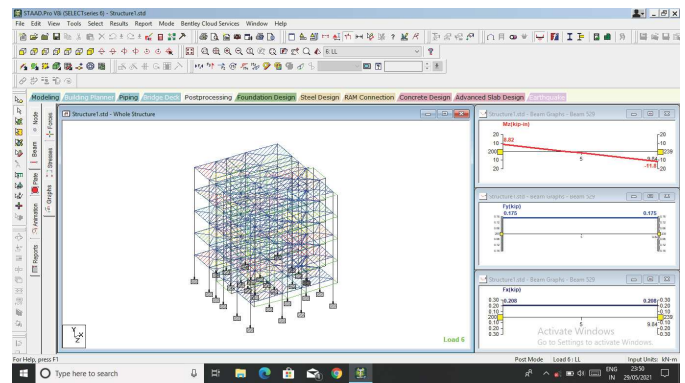
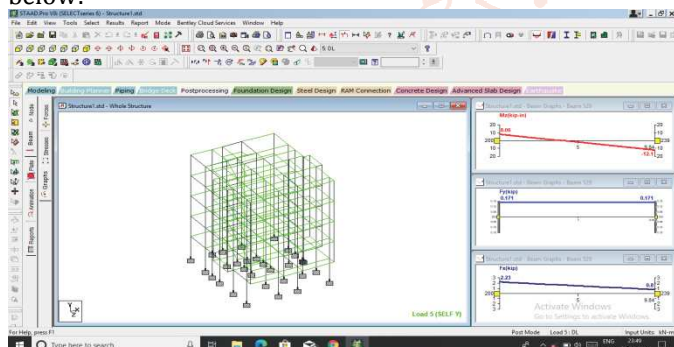
Gokdemiret.al (2013):- Presents paper on effect of torsional irregularity on buildings. Structural irregularities are important factors which decrease the seismic performance of the structures. Buildings which have structural irregularities may experience different drifts of adjacent stories, excessive torsion, etc. according to irregularity type and fail during an earthquake. In this study building models, which have different number of floors and floor areas, are generated by a computer program and calculations are made. Results are compared and precautions are given to prevent damages caused by torsional irregularity under earthquake loads. They concluded that, separating big building sections from each other with proper separation distances and increasing lateral rigidity on the weak direction of the structures decrease the effect of torsion. In addition, torsional irregularity may separated from each other properly. Simply, increasing strength of structural elements on the weak direction of the building or decreasing strength of structural elements on the strong direction can prevent effects of torsion on structures. and least displacement was observed in building of lower one. It indicates that building with severe irregularity shows maximum displacement and storey drift.

ANALYSIS METHODS

Seismic analysis is a subset of structural analysis and is the calculation of the response of the building structure to earthquake and is a relevant part of structural design where earthquakes are prevalent. The seismic analysis of a structure involves evaluation of the earthquake forces acting at various level of the structure during an earthquake and the effect of such forces on the behaviour of the overall structure. The analysis may be static or dynamic in approach as per the code provisions. Thus broadly we can say that linear analysis of structures to compute the earthquake forces is commonly based on one of the following three approaches.

1. An equivalent lateral procedure in which dynamic effects are approximated by horizontal static forces applied to the structure. This method is quasi-dynamic in nature and is termed as the Seismic Coefficient Method in the IS code.
2. The Response Spectrum Approach in which the effects on the structure are related to the response of simple, single degree of freedom oscillators of varying natural periods to earthquake shaking.
3. Response History Method or Time History Method in which direct input of the time history of a designed earthquake into a mathematical model of the structure using computer analyses.

Analysis of the structure is shown with the help of images below:



CONCLUSION

From the above literature papers conclusion is as follow: Most of the studies have focused on investigating two types of irregularities: those in set-back and soft and/or weak first story structures. Conflicting conclusions have been found for the set-back structures; most of the studies, however, agree on the increase in drift demand for the tower portion of the set-back structures. For the fully in filled frames with rigid base, no collisions between buildings were observed and the structures vibrated independently during difference earthquakes. This is attributed to the limited displacement values due to the existence of infill. On the other hand, taking SSI into consideration increases the overall feasibility of both buildings. It shifts the natural period and hence increases the displacements. If the increased displacements result in collisions, significant increase in the acceleration values at the locations of collisions takes place.

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